HIGH TEST PEROXIDE (H.T.P.) (H_2O_2)

Properties: Specific Gravity: 80% 1·3341.
100% 1·4403.
Boiling Point: 155·5°C. (312°F.).
Freezing Point: 80% −25°C. (−13°F.).
100% 0°C. (32°F.).
Heat of Decomposition to $H_2O + \frac{1}{2}O_2$ at 25°C.: 380 cal./g.

Description: H.T.P. is a concentrated solution, usually between 80% and 90%, of hydrogen peroxide in water, and is dense, water-white, and corrosive.

Uses: H.T.P. is a convenient source of heat. Each pound of 90% H.T.P. at 32°F. will, upon decomposition to liquid (water) and oxygen gas, release 1109 B.T.U., which convert the water product to superheated steam at approximately 1300°F.

H.T.P. is also used as a source of high-pressure gas for driving turbine machinery, etc., being decomposed catalytically in the presence of silver or copper or other suitable material.

Lastly it is employed as a simple oxidant, being combined with such other chemicals as aluminium borohydride, cyclohexane, hydrazine, kerosene, methyl alcohol, and nitromethane, to form rocket propellant.

Fire Hazard: H.T.P. itself is not inflammable, but will vigorously support combustion and form explosive mixtures with kerosene, oils, greases, and similar organic materials, although such mixtures may not be self-igniting.

Temperatures of over 1000°F. can be obtained from the rapid decomposition of contaminated H.T.P., which will cause self-igniting fires when the liquid is spilled on combustible material, such as clothing. Inadvertent ignition can

also result from sparks or static charges, or the subsequent bringing of a flame near to material previously soaked in H.T.P. It is catalysed by most materials, except pure aluminium, certain stainless steels, P.V.C., P.T.F.E., glass, and glazed ceramics.

It is, therefore, a dangerous fire hazard.

In fire fighting, only water may be used.

Explosion Hazard: The action of detonators on H.T.P. has shown that it is possible to partially explode 90% material if it is closely confined, and under severe conditions of shock and confinement it has been known to detonate at 80%–85% strength.

Health Hazard: H.T.P. is non-toxic although the vapours given off will irritate the nose and eyes. Exposure to a heavy mist of H.T.P. droplets is to be avoided due to its possible effect as a lung and eye irritant.

After short physical contact with the liquid, white irritating patches develop on the skin. If the liquid is washed off immediately, no harm results and the patch disappears after a few hours. Prolonged contact, however, will cause painful burns, due to the corrosive action of the material, and prompt medical attention is necessary in these cases. Care should be taken to prevent H.T.P. entering cuts, scratches, or beneath finger nails and cuticles, where it causes considerable pain.

H.T.P. in the eyes is painful and may be dangerous if not immediately washed out and flushed with water. Prompt medical attention is always essential.

When diluted with at least four parts by volume of water, H.T.P. becomes relatively harmless. A plunge bath should therefore be provided for the total immersion of persons upon whom H.T.P. has been spilled. Showers, with a foot-treadle operated valve, should additionally be made available for persons less seriously contaminated. In either case the temperature of the water should be maintained at about 100°F. to minimize and prevent further shock.

Personal Protection:

1. Before attempting to handle H.T.P., personnel should be protected with suitable clothing. For small laboratory quantities of the liquid, this consists of:

(*a*) Rubber gloves or P.V.C. gloves.
(*b*) Rubber boots.
(*c*) Face visor or, at the very least, chemical safety goggles.
(*d*) P.V.C. coat or apron extending from chin to below tops of boots.

When bulk quantities are being handled or moved from place to place, the following should be worn:

(*a*) Rubber or P.V.C. gloves.
(*b*) Rubber boots.
(*c*) P.V.C. jacket and trousers, or one-piece suit.
(*d*) Head cowl or, at the very least, a face shield.

The cuffs of the jacket and the bottoms of the trousers and the overlap at the waist between the two garments should be so designed as to prevent the catchment and ingress of H.T.P. at these points.

2. There should always be two or more persons present, suitably clad, whenever H.T.P. is being handled.

3. There should always be provided a hose of running water, in addition to the showers and plunge bath, whenever H.T.P. is being handled.

4. Do not smoke or allow any naked flame or sparks in the vicinity of H.T.P.

5. Any skin or eye contact with H.T.P. must be flushed with copious amounts of water to remove all danger of burn injury. If it is allowed to remain on the skin long enough for a burn to develop, medical attention must be sought.

6. Where large quantities of H.T.P. are splashed or spilled on the person, complete dousing is to be resorted to, either by means of the shower bath or by immersion in the plunge bath.

7. Protective clothing must be washed with water immediately after contamination with H.T.P. is known to have taken place, and in any case after each period of use. It

should be suspended from hangers to dry and should be kept thereon.

Passivation: Surfaces that come into contact with the material should be specially treated prior to use to prevent excessive decomposition of the H.T.P. This process, known as passivation, renders the surface inactive, and consists of treating the metal with acids or other chemicals to form an oxide film with which the H.T.P. comes into contact. The film is thus a layer between the H.T.P. and the metal surface, and prevents the H.T.P. attacking the metal, or the metal decomposing the H.T.P.

Decomposition: Although stable when pure, H.T.P. is decomposed catalytically by traces of copper, silver, iron, manganese, and by all organic materials, foreign bodies, dirt, etc. This decomposition is irreversible and continuous, but slows down below 40°C. (104°F.). In a large volume of H.T.P. or where the liquid is confined, the presence of catalytic substances can lead to serious explosions due to the confinement of gas.

Handling: Whenever any operations are undertaken involving the handling of H.T.P. it is essential to have plenty of water available, preferably from a hose, and two or more operators present, suitably clad. In any instance of spillage, the affected area should immediately be doused with water, and similar treatment accorded any contaminated personnel.

Quantities should be moved from place to place in metal rather than glass containers to avoid the risk of spilling by breakage. However, laboratory samples may be transported in glass bottles provided they are placed in a metal container and packed around with Kieselguhr and accompanied by a quantity of water not less than five times the amount by volume of H.T.P.

Storage: No smoking may be permitted within 50 feet of any area wherein H.T.P. is stored.

(*a*) *Bulk Storage*. Site bulk storage should be in clearly

labelled tanks made of pure (99·5% or above) aluminium, maintained in a state of scrupulous cleanliness. Particular attention must be paid to the interior surfaces of the tanks, and any dirt must be removed by gentle scraping.

Storage tanks should be erected under a light roof, or even in the open, in a compound provided with an adequate water supply and a means of adequate drainage. Stand pipes and hoses should be provided at convenient points for the emergency dilution and cooling of H.T.P., for washing tanks, pumps, and utensils generally, and for spraying to keep down dust. Overhead sprinklers should be provided for cooling the tanks.

All tanks should be fitted with lids and breather traps and should be equipped with some means of determining the quantity and temperature of the liquid. At least one tank should be set apart in a compound for emergency transfer, as described later, whilst the provision of another, smaller tank as an expense tank is desirable.

Tank connections should be provided so that it is possible to flush out all pipe lines, pumps, etc., with water, and joints on all such connections should be made of polyvinyl chloride, polythene, or polytetrafluoroethylene. Blank flanges must be of pure aluminium.

(*b*) *Laboratory Quantities.* Laboratory bulk quantities can be stored in a cool building or shelter, provided that there is no inflammable material nearby and that there is plenty of water available. The liquid should be kept in aluminium containers of approved design, the vent being so designed as to prevent the entry of dust, foreign bodies, etc. These containers should not be more than 75% full. Winchester quart bottles of unstabilized H.T.P. for immediate laboratory use should be made from dark glass and should be kept cool.

(*c*) *Store Maintenance.* The maintenance of an H.T.P. store should be a full-time job, or a prime responsibility, for a responsible person who shall inspect each tank or container each day, and record its temperature and H.T.P. content.

On the first day of each month a sample of the liquid should be taken and its temperature and density recorded.

A log book should be maintained for each tank to record all inspections, tests, deliveries, supplies, quantities, temperatures, and measurements. The storage compound should be equipped with a metal ladder to give access to the tops of the tanks; also with suitable aluminium vessels for taking samples; also with a calibrated aluminium dipstick for measuring quantities; also with two or three galvanized bins containing water for priming pumps, washing gear, etc.; and also with a stainless steel tank of some 200–500 gallons capacity depending upon the size of the store, for holding distilled water in the event of the mains water being chemically unsuitable for washing purposes.

In the event of the contents of a tank becoming overheated, an attempt should be made to cool it with water sprays and jets. If this treatment is effective in reducing the temperature to ambient, then a sample of H.T.P. should be taken for analysis, and the remainder carefully watched for any further deterioration. If, however, the tank temperature continues to rise in spite of the cooling technique, the H.T.P. should be dumped when its temperature reaches 3°F. (1·7°C.) above the mean ambient of the previous 24 hours. Whilst the tank is being emptied, the contents should be diluted with water from hoses.

No H.T.P. shall be returned to storage at the end of any tests, all H.T.P. remaining unused being returned to the expense tank or considerably diluted and run to waste. If a foreign body (i.e. a spanner, washer, or piece of dirt) is dropped into a tank, the contents should be immediately transferred into an empty tank, or dumped, according to quantity, provided that in the case of transferring to an empty tank excessive overheating has not taken place. If it has, dumping should be immediately carried out. The transferred H.T.P. should be carefully watched, and if its temperature remains at ambient a sample should be taken for analysis. If its temperature continues to rise, however, the stock should be dumped.

Storage tanks should be emptied in succession, and new consignments should not be unloaded into tanks containing old stocks which may have aged. Storage tanks should not be filled to more than 75% capacity, to allow for the normal evolution of oxygen, and to provide a safety space in the event of decomposition.

If a small portable tanker trolley is used, facilities shall be provided for immediately dumping the contents if they become overheated or contaminated. Unless it is to be used again within 24 hours, the H.T.P. trolley is to be emptied after the day's use and thoroughly washed, the final rinse being with distilled water. At approximately four monthly intervals the trolley is to be dismantled and all parts examined, repaired, or replaced as necessary.